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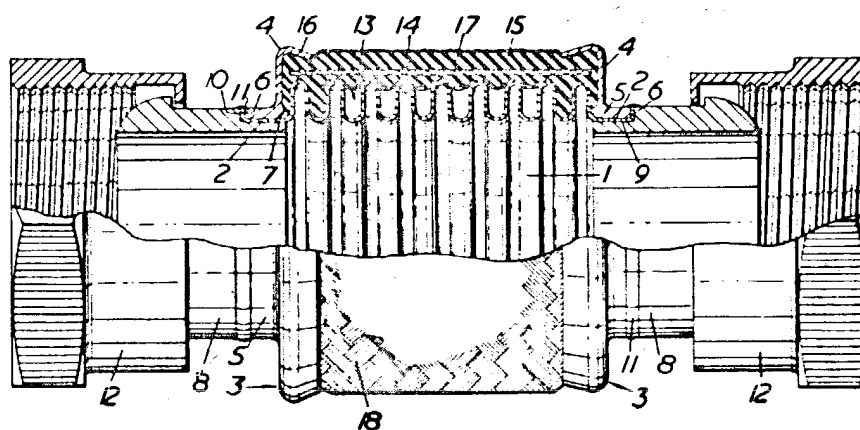
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# PATENT SPECIFICATION

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## COMPLETE SPECIFICATION

### Improvements in or relating to Flexible Metal Pipe and like Couplings

We, K.A.C. LIMITED, a British Company, of Fifth Street, Montrose Avenue, Hillington, Glasgow, S.W.2, Scotland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns improvements in or relating to flexible metal pipe and like couplings, and has particular reference to flexible couplings of the kind comprising a pair of unions fluid-tightly connected by a length of corrugated metal tubing.

Flexible metal couplings of the kind referred to are frequently subjected in use to considerable internal and external stresses and are found to be a source of weakness in piping systems, and it is therefore an object of this invention to provide a new or improved flexible metal coupling of the kind referred to and which is less liable to failure in use than couplings of comparative cost and character.

According to this invention there is provided a flexible metal pipe coupling comprising a pair of unions fluid-tightly connected by a length of corrugated metal tubing, wherein an annular flange is provided around each end of the length of tubing, and around the latter and between the said flanges is located a sheath of rubber, silicone rubber, or other rubber composition or like plastic elastic and resilient material, such sheath being bonded at its ends respectively to the said two flanges and moulded over the tubing and into at least the end convolutions thereof.

The said length of corrugated tubing may have annular or helical corrugations, as desired, but will preferably be a bellows having helical corrugations.

According to a further feature of the invention a flexible covering is located between the said sheath and the length of tubing to

seal the cavities between the crests of successive convolutions thereof, said covering extending around the length of tubing and closing all those convolutions into which it is not desired that the material of the sheath should penetrate. In general, all the convolutions except the last one or two at each end of the length of tubing will be so closed.

Said covering may conveniently be a fabric covering and may be applied to the length of tubing as a single turn of a wide material or in the form of a tape wound thereon.

Desirably an internal reinforcement may be embedded in said sheath and conveniently said reinforcement may be a strip of wire gauze or the like embedded in the sheath in the form of a tube surrounding, and coaxial with, the length of tubing and extending substantially the full length of the sheath. Such reinforcement besides strengthening the sheath, would, in the case of fire, baffle the flame before burning through and thus reduce the risk of failure of the coupling due to fire. Although, as stated above, the reinforcement is conveniently formed of wire gauze, it could, of course, be formed of metal mesh or fire-resistant fabric braid or mesh, if desired.

The said rubber or like sheath may itself be enclosed in a covering of a reinforcing or protective material which may, for example, comprise tubular metal braiding.

According to a further feature of the invention the said flanges comprise annular discs having tubular coaxial bosses, into which fit the cylindrical ends of the length of tubing, these cylindrical ends being secured to said tubular bosses in a fluid tight and permanent manner.

The said flanges are also preferably of an external diameter greater than the overall outside diameter of the length of tubing and its enclosing sheath and other coverings, and, after the assembly of the said sheath and other

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coverings upon the length of tubing the outer marginal portions of the flanges are spun inwardly down on to the said coverings to confine the end portions thereof and press them inwardly, the inspun marginal portions of the flanges preferably assuming an inwardly convergent frusto-conical form so that the inner edges of such portions press into the said sheath and any covering enclosing the latter at a short distance from the ends of the length of tubing.

According to a further feature of the invention the said cylindrical end portions of the length of tubing pass outwardly through the tubular bosses of the said flanges and then turn outwardly so as to fit closely against the outer ends of the tubular bosses of said flanges.

According to a still further feature of the invention each of the unions comprises a tubular spigot having an annular external rebate at the end to be engaged with the length of corrugated metal tubing, such rebated end fitting tightly in the bore of the corresponding cylindrical end portion of the length of tubing and trapping such cylindrical end portion between the spigot and the tubular boss of the corresponding flange, whilst the outwardly turned extreme end of the length of tubing is trapped between the outer end face of the tubular boss of the flange and the inner surface of the shoulder formed by the rebating of the tubular spigot of the union, all of these three parts being secured rigidly in a fluid tight manner, e.g. by brazing.

The said tubular spigots may be of male or female form and may conveniently be in the nature of "olives" each provided with an enlarged outer end on which is rotatably mounted a union nut.

This invention also includes a method of forming a flexible metal pipe coupling according to this invention.

In order that the invention may more readily be understood reference will now be made, by way of example, to the accompanying drawings in which:—

The only Figure is a part longitudinal section of a flexible metal pipe coupling according to this invention.

The coupling illustrated comprises an annularly corrugated metal bellows 1 having a cylindrical outwardly extending coaxial portion 2 at each end, these cylindrical end portions being of the same internal diameter as the troughs of the corrugations of the bellows. On each of the cylindrical end portions 2 of the bellows 1 is threaded a flange 3 comprising an annular flange disc 4 having a tubular coaxial boss 5, each tubular boss 5 being a close fit upon the corresponding cylindrical end portion 2 and each disc 4 being located nearer to the inner end of its respective boss than to the outer end thereof. The axial length of each tubular boss 5 is smaller than the axial length of the cylindrical end

portion 2 of the bellows 1 on to which it is fitted, and, after each flange 3 has been applied thereto, the corresponding outer marginal portion 6 of the bellows 1 is spun outwardly into engagement with the outer end of the tubular boss 5 so as to retain the flange 3 firmly on the cylindrical end portion 2 of the bellows, such outwardly spun marginal portion 6 being substantially flush with the outside diameter of the tubular boss 5 and the inner corners 7 of the latter preferably being radiused or rounded.

The cylindrical end portions 2 of the bellows are preferably spun as a whole into the bores of their respective end flanges 3 so as to be snug fits therein.

End unions comprising tubular spigots 8, each of which has its inner end rebated externally and annularly so as to provide an annular recess 9 for receiving one end of the bellows 1 and the tubular boss 5 of the flange 3 encircling it, are attached to the bellows 1, the rebated end of each spigot 8 being pushed tightly into the corresponding cylindrical end of the bellows, the extent to which the spigot 8 can move into the bellows 1 being limited by the engagement of the shoulder 10, formed by rebating the spigot, against the outspun marginal portion 6 of the bellows. The coupling having been assembled thus far, the tubular spigots 8, the outspun marginal portions 6 of the bellows 1 and the tubular bosses 5 of the flanges 3 are united together by an annular brazed joint 11 made around the ends of the coupling at the junction of the above recited parts.

Where rotatably mounted union nuts, such as are indicated by the reference 12, are to be provided on the spigots 8, these nuts are of course assembled on the spigots before the latter are inserted into and joined rigidly with the bellows and the end flanges thereof.

Fabric 13 is now wrapped around the outside of the bellows 1 over an appropriate length thereof but leaving the last one or two corrugations of the bellows uncovered. Thus all the corrugations will preferably be covered except each end corrugation and the annular recess between the outer end corrugation and the inner surface of the adjacent end flange 3 of the coupling, the fabric 13 extending between the crests 14 of the covered corrugations so that the troughs of these corrugations are closed externally.

Now, rubber or like material, e.g. silicone rubber composition, which is heat and oil resistant, is moulded over the bellows and the fabric 13 and down into the corrugations not covered thereby as well as into the annular recesses between the end flanges 3 and the end corrugations of the bellows to fill these recesses and the troughs of the said last corrugations of the bellows, and is bonded in any suitable manner to the inside surfaces of the end flanges 3. The said rubber or like material

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forms a sheath 15 extending entirely around the bellows to a suitable thickness, and which is less than the radial extent to which the flange discs 4 project from the bellows 1 so that an annular marginal portion 16 on each of these flange discs is left which can be spun inwardly and downwardly into approximately frusto-conical form gripping and protecting the ends of the sheath 15. Advantageously a strip of wire gauze 17 may be embedded in the sheath 15 as the latter is moulded over the bellows, the strip 17 forming a tube surrounding and coaxial with the bellows 1.

If desired, a braided metal or other covering 18 may be provided around the sheath 15 before the marginal portions 16 of the flanges 3 are spun inwardly.

By constructing the coupling in the manner above described, additional security is achieved whilst not reducing to any appreciable extent the flexibility of the coupling. The rubber composition reinforces the corrugated metal tubing or bellows and in addition damps out vibrations which might be induced therein in use and which might result in fracture of the bellows.

Although, according to this invention, the said bellows may, as hereinbefore stated, be provided with annular or helical corrugations, when the bellows have annular corrugations, the additional advantage is obtained that the rubber or like sheath serves to seal, at least temporarily, and to localise any fracture that might develop in the metal bellows at any point therein.

What we claim is:—

1. A flexible metal pipe coupling comprising a pair of unions fluid-tightly connected by a length of corrugated metal tubing, wherein an annular flange is provided around each end of the length of tubing, and around the latter and between the said flanges is located a sheath of rubber, silicone rubber, or other rubber composition or like plastic elastic and resilient material, such sheath being bonded at its ends respectively to the said two flanges and moulded over the tubing and into at least the end convolutions thereof.

2. A flexible metal pipe coupling according to claim 1, wherein the said length of corrugated metal tubing is a bellows having annular corrugations.

3. A flexible metal pipe coupling according to claim 1 or 2, wherein a flexible covering is located between the said sheath and the length of tubing to seal the cavities between the crests of successive convolutions thereof, said covering extending around the length of tubing and closing all those convolutions into which it is not desired that the material of the sheath should penetrate.

4. A flexible metal pipe coupling according to claim 1, 2 or 3, wherein an internal reinforcement is embedded in said sheath.

5. A flexible metal pipe coupling according

to claim 4, wherein said reinforcement is a strip of wire gauze or the like embedded in the sheath in the form of a tube surrounding and coaxial with the length of tubing and extending substantially the full length of the sheath.

6. A flexible metal pipe coupling according to any of the preceding claims, wherein said sheath is enclosed in a covering of a reinforcement or protective material.

7. A flexible metal pipe coupling according to any of the preceding claims, wherein the said flanges comprise annular discs having tubular coaxial bosses into which fit the cylindrical ends of the length of tubing.

8. A flexible metal pipe coupling according to claim 7, wherein the said cylindrical end portions of the length of tubing pass outwardly through the tubular bosses of the said flanges and then turn outwardly so as to fit closely against the outer ends of the tubular bosses of said flanges.

9. A flexible metal pipe coupling according to claim 8, wherein each of said unions comprises a tubular spigot having an annular external rebate at the end to be engaged with the length of corrugated metal tubing, such rebated end fitting tightly in the bore of the corresponding cylindrical end portion of the length of tubing and trapping such cylindrical end portion between the spigot and the tubular boss of the corresponding flange, whilst the outwardly turned extreme end of the length of tubing is trapped between the outer end face of the tubular boss of the flange and the inner surface of the shoulder formed by the rebating of the tubular spigot of the union, all of these three parts being secured rigidly in a fluid tight manner, e.g. by brazing.

10. A flexible metal pipe coupling according to any of the preceding claims, wherein each of said unions comprises a tubular spigot in the nature of an "olive" provided with an enlarged outer end on which is rotatably mounted a union nut.

11. A method of forming a flexible metal pipe coupling comprising the steps of threading onto each end portion of a length of corrugated metal tubing a flange comprising an annular disc having a tubular coaxial boss, spinning each of the outer marginal portions of the length of tubing outwardly into engagement with the outer end of the tubular boss of the corresponding flange, securing an end union, comprising a tubular spigot having its inner end rebated externally and annularly, on to each end of the length of tubing by inserting the rebated end of the spigot into the corresponding end of the length of tubing until the shoulder formed by the rebating of the spigot engages against the corresponding outspun marginal portion of the length of tubing and uniting the tubular spigots, the outspun marginal portions of the length of tubing and the tubular bosses of the flanges at

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- the junction of these parts, wrapping a flexible material, e.g. fabric, around the outside of the length of tubing but leaving the last one or two convolutions thereof uncovered, moulding rubber or like material over the tubing and said fabric and down into convolutions of the tubing not covered by the fabric and bending such material to the inside surfaces of the end flanges to form a sheath extending around the length of tubing, and spinning an annular marginal portion of each flange inwardly and downwardly, preferably in to approximately frusto-conical form, to grip the ends of the said sheath.
12. A method according to claim 12, wherein, during the moulding of the sheath, a strip of wire gauze or like reinforcement is embedded therein to form a tube encircling the said length of tubing.
13. A method according to claim 11 or 12, wherein, before the marginal portions of said flanges are spun inwardly, a protective covering is provided around the said sheath.
14. A method of forming a flexible metal pipe coupling substantially as herein described with reference to the figure of the accompanying drawings.
15. A flexible metal pipe coupling substantially as herein described with reference to and as shown by the figure of the accompanying drawings.

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# PROVISIONAL SPECIFICATION

No. 14282 A.D. 1954.

## Improvements in or relating to Flexible Metal Pipe and like Couplings

We, K.A.C. LIMITED, a British Company, of Fifth Street, Montrose Avenue, Hillington, Glasgow, S.W.2, Scotland, do hereby declare this invention to be described in the following statement:—

This invention concerns improvements in or relating to flexible metal pipe and like couplings, and has particular reference to flexible couplings of the kind comprising a pair of unions fluid-tightly connected by a length of corrugated metal tubing or bellows (hereinafter called "bellows").

Flexible metal couplings of the kind referred to are frequently subjected in use to considerable internal and external stresses and are found to be a source of weakness in piping systems, and it is therefore an object of this invention to provide a new or improved flexible metal coupling of the kind referred to and which is less liable to failure in use than couplings of comparative cost and character.

According to this invention there is provided a flexible metal pipe or like coupling of the kind referred to, wherein an annular flange is provided around each end of the bellows, and around the latter and between the said flanges is located a sheath of rubber, silicone rubber, or other rubber composition or like plastic elastic and resilient material, which sheath is bonded at its ends respectively to the said two flanges, and which is moulded over the bellows and into at least one or two of the end convolutions at each end thereof.

The said corrugated tubing or bellows may have annular or helical corrugations, as desired.

According to a further feature of the invention a flexible covering is located between the said sheath of moulded rubber or like material and the bellows to seal the cavities between the crests of successive convolutions thereof, said covering extending around the bellows and closing all those convolutions into which it is not desired that the rubber or like material of the sheath should penetrate. In general, all the convolutions except the last one or two at each end of the bellows will be so closed.

Said covering may conveniently be a fabric covering and may be applied to the bellows as a single turn of a wide material or in the form of a tape wound thereon. The said rubber or like sheath may itself be enclosed in a covering of a reinforcing or protective material which may, for example, comprise tubular metal braiding.

According to a further feature of the invention the said flanges comprise annular discs having tubular coaxial bosses, into which are introduced the cylindrical ends of the bellows, these cylindrical ends being secured to said tubular bosses in a fluid tight and permanent manner.

The said flanges are also preferably of an external diameter greater than the overall outside diameter of the bellows and its enclosing sheath and other coverings, and, after the assembly of the said sheath and other coverings upon the bellows, the outer marginal portions of the flanges are spun inwardly down on to the said coverings to confine the end portions thereof and press them inwardly, the

inspun marginal portions of the flanges preferably assuming an inwardly convergent frusto-conical form so that the inner edges of such portions press into the said moulded rubber or like sheath and any covering enclosing the latter at a short distance from the ends of the bellows.

According to a further feature of the invention the said cylindrical end portions of the bellows are passed outwardly through the tubular bosses of the said end flanges and are then turned outwardly preferably by a spinning operation so as to fit closely against the outer ends of the tubular bosses of said flanges to which they are subsequently secured, as by brazing. This brazing operation at the same time preferably unites the corresponding union to the end of the unit formed by the bellows, the end flanges and the coverings for the bellows.

According to a still further feature of the invention each of the end unions comprises a tubular spigot having an annular external rebate at the end to be engaged with the bellows, this rebated end being adapted to fit tightly into the bore of the corresponding cylindrical end portion of the bellows and to trap such cylindrical end portion of the bellows between the spigot and the tubular boss of the corresponding end flange, whilst the outwardly spun extreme end of the cylindrical part of the bellows is trapped between the outer end face of the tubular boss of the flange and the inner surface of the shoulder formed by rebating the tubular spigot of the union, all these three parts being secured rigidly in a fluid tight manner preferably by brazing or similar operation.

The said tubular spigots may be of male or female form and may conveniently be in the nature of "olives" each provided with an enlarged outer end on which is rotatably mounted a union nut.

In order that the invention may be more readily understood one embodiment of the same will now be described by way of example, as applied to a flexible metal pipe coupling.

This coupling comprises an annularly corrugated metal bellows having a cylindrical outwardly extending coaxial portion at each end, these cylindrical end portions being of the same internal diameter as the troughs of the corrugations of the bellows. On each of such cylindrical end portions of the bellows is threaded the tubular boss of an end flange, each tubular boss being a close fit upon the corresponding cylindrical end portion of the bellows, and each flange being located nearer to the inner end of its respective boss than to the outer end thereof. The axial length of each tubular boss is smaller than the axial length of the cylindrical end portion of the bellows on to which it is fitted, and, after each flange has been applied thereto the corresponding outer marginal portion of the bellows

is spun outwardly into engagement with the outer end of the tubular boss of the flange so as to retain the latter and its boss firmly on the cylindrical end portion of the bellows, such outwardly spun marginal portion of the bellows being substantially flush with the outside diameter of the tubular boss of the flange and the inner corners of the said tubular boss preferably being radiused or rounded.

The said cylindrical end portions of the bellows are spun as a whole into the bores of their respective end flanges so as to snug fits therein.

End unions comprising tubular spigots, each of which has its inner end rebated externally and annularly so as to provide an annular recess for receiving one end of the bellows and the boss of the tubular flange encircling it, are attached to the bellows, the rebated end of the spigot being pushed tightly into the cylindrical end of the bellows, the extent to which the spigot can move into the bellows being limited by the engagement of the shoulder formed by rebating the spigot against the outspun marginal portion of the bellows. The coupling having been assembled thus far, the tubular spigots, the outspun marginal portions of the bellows and the tubular bosses of the said flanges are united together by an annular brazed joint being made extending around the ends of the coupling at the junction of the above recited parts.

Where rotatably mounted union nuts are to be provided on the said spigots, these nuts are of course assembled on the spigots before the latter are inserted into and joined rigidly with the bellows and the end flanges thereof.

Fabric is now wrapped around the outside of the bellows over an appropriate length thereof but leaving the last one or two corrugations of the bellows uncovered. Thus all the corrugations will preferably be covered except each end corrugations and the annular recess between the outer end corrugation and the inner surface of the adjacent end flange of the coupling, the said fabric extending between the crests of the covered corrugations so that the troughs of these corrugations are closed externally.

Now, rubber or like material, e.g. silicone rubber composition, which is heat and oil resistant, is moulded over the bellows and the said fabric and down into the corrugations not covered thereby as well as the annular recesses between the said end flanges and the end corrugations of the bellows to fill these recesses and the troughs of the said last corrugations of the bellows, and is bonded in any suitable manner to the inside surfaces of the end flanges. The said rubber or like material forms a sheath extending entirely around the bellows to a suitable thickness, which is, less than the radial extent to which the said flanges project from the bellows so that an annular marginal portion on each of these flanges is

tubular bosses in a fluid tight and permanent manner.

5 The said flanges are also preferably of an external diameter greater than the overall outside diameter of the bellows and its enclosing sheath and other coverings, and, after the assembly of the said sheath and other coverings upon the bellows, the outer marginal portions of the flanges are spun inwardly down  
10 on to the said coverings to confine the end portions thereof and press them inwardly, the inspun marginal portions of the flanges preferably assuming an inwardly convergent frusto-conical form so that the inner edges of such  
15 portions press into the said moulded rubber or like sheath and any covering enclosing the latter at a short distance from the ends of the bellows.

20 According to a further feature of the invention the said cylindrical end portions of the bellows are passed outwardly through the tubular bosses of the said end flanges and are then turned outwardly preferably by a spinning operation so as to fit closely against the  
25 outer ends of the tubular bosses of said flanges to which they are subsequently secured, as by brazing. This brazing operation at the same time preferably unites the corresponding union to the end of the unit formed by the bellows,  
30 the end flanges and the coverings for the bellows.

35 According to a still further feature of the invention each of the end unions comprises a tubular spigot having an annular external rebate at the end to be engaged with the bellows, this rebated end being adapted to fit tightly into the bore of the corresponding cylindrical  
40 end portion of the bellows and to trap such cylindrical end portion of the bellows between the spigot and the tubular boss of the corresponding end flange, whilst the outwardly spun extreme end of the cylindrical part of the  
45 bellows is trapped between the outer end face of the tubular boss of the flange and the inner surface of the shoulder formed by rebating the tubular spigot of the union, all these three parts being secured rigidly in a fluid tight manner preferably by brazing or similar operation.

50 The said tubular spigots may be of male or female form and may conveniently be in the nature of "olives" each provided with an enlarged outer end on which is rotatably mounted a union nut.

55 In order that the invention may be more readily understood one embodiment of the same will now be described by way of example, as applied to a flexible metal pipe coupling.

60 This coupling comprises an annularly corrugated metal bellows having a cylindrical outwardly extending end portion at each end, these cylindrical end portions being of the same internal diameter as the troughs of the corrugations of the bellows. On each of such cylindrical end portions of the bellows is threaded  
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the tubular boss of an end flange, each tubular boss being a close fit upon the corresponding cylindrical end portion of the bellows, and each flange being located nearer to the inner end of its respective boss than to the outer end thereof. The axial length of each tubular boss is smaller than the axial length of the cylindrical end portion of the bellows on to which it is fitted, and, after each flange has been applied thereto the corresponding outer marginal portion of the bellows is spun outwardly into engagement with the outer end of the tubular boss of the flange so as to retain the latter and its boss firmly on the cylindrical end portion of the bellows, such outwardly spun marginal portion of the bellows being substantially flush with the outside diameter of the tubular boss of the flange and the inner corners of the said tubular boss preferably being radiused or rounded.

The said cylindrical end portions of the bellows are spun as a whole into the bores of their respective end flanges so as to be snug fits therein.

End unions comprising tubular spigots, each of which has its inner end rebated externally and annularly so as to provide an annular recess for receiving one end of the bellows and the boss of the tubular flange encircling it, are attached to the bellows, the rebated end of the spigot being pushed tightly into the cylindrical end of the bellows, the extent to which the spigot can move into the bellows being limited by the engagement of the shoulder formed by rebating the spigot against the outspun marginal portion of the bellows. The coupling having been assembled thus far, the tubular spigots, the outspun marginal portions of the bellows and the tubular bosses of the said flanges are united together by an annular brazed joint being made extending around the ends of the coupling at the junction of the above recited parts.

Where rotatably mounted union nuts are to be provided on the said spigots, these nuts are of course assembled on the spigots before the latter are inserted into and joined rigidly with the bellows and the end flanges thereof.

Fabric is now wrapped around the outside of the bellows over an appropriate length thereof but leaving the last one or two corrugations of the bellows uncovered. Thus all the corrugations will preferably be covered except each end corrugation and the annular recess between the outer end corrugation and the inner surface of the adjacent end flange of the coupling, the said fabric extending between the crests of the covered corrugations so that the troughs of these corrugations are closed externally.

Now, rubber or like material, e.g. silicone rubber composition, which is heat and oil resistant, is moulded over the bellows and the said fabric and down into the corrugations not covered thereby as well as the annular recesses



left which can be spun inwardly and downwardly into approximately frusto-conical form gripping and protecting the ends of the said rubber or like sheath.

- 5 If desired, a braided metal or other covering or coverings may be provided around the said rubber or like sheath before the marginal portions of the said flanges are spun inwardly.

- 10 By constructing the coupling element in the manner above described, additional security is achieved whilst not reducing to any appreciable extent the flexibility of the coupling. The rubber composition reinforces the corrugated metal tubing or bellows and in addition damps out vibrations which might be induced therein in use and which might result in fracture of the bellows.

Although, according to this invention, the said bellows may as hereinbefore stated be provided with annular or helical corrugations, when the bellows have annular corrugations, the additional advantage is obtained in that the rubber or like sheath serves to seal, at least temporary, and to localise any fracture that might develop in the metal bellows at any point therein.

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### PROVISIONAL SPECIFICATION

No. 16796 A.D. 1954.

### Improvements in or relating to Flexible Metal Pipe and like Couplings

- 30 We, K.A.C. LIMITED, a British Company, of Fifth Street, Montrose Avenue, Hillington, Glasgow, S.W.2, Scotland, do hereby declare this invention to be described in the following statement:—

- 35 This invention concerns improvements in or relating to flexible metal pipe and like couplings, and has particular reference to flexible couplings of the kind comprising a pair of unions fluid-tightly connected by a length of corrugated metal tubing or bellows (hereinafter called "bellows").

- 40 Flexible metal couplings of the kind referred to are frequently subjected in use to considerable internal and external stresses and are found to be a source of weakness in piping systems, and it is therefore an object of this invention to provide a new or improved flexible metal coupling of the kind referred to and which is less liable to failure in use than couplings of comparative cost and character.

- 45 According to this invention there is provided a flexible metal pipe or like coupling of the kind referred to, wherein an annular flange is provided around each end of the bellows, and around the latter and between the said flanges is located a sheath of rubber, silicone rubber, or other rubber composition

- 50 or like plastic elastic and resilient material, which sheath is bonded at its ends respectively to the said two flanges, and which is moulded over the bellows and into at least one or two of the end convolutions at each end thereof.

- 55 The said corrugated tubing or bellows may have annular or helical corrugations, as desired.

According to a further feature of the invention a flexible covering is located between the

65 said sheath of moulded rubber or like material and the bellows to seal the cavities between the crests of successive convolutions thereof, said covering extending around the bellows and closing all those convolutions into which it is not desired that the rubber or like material of the sheath should penetrate. In general, all the convolutions except the last one or two at each end of the bellows will be so closed.

70 Said covering may conveniently be a fabric covering and may be applied to the bellows as a single turn of a wide material or in the form of a tape wound thereon.

According to a further feature of this invention, an internal reinforcement may be provided embedded in said rubber or like sheath.

75 Conveniently said reinforcement may be a strip of wire gauze wound in the sheath so as to form a tube internally thereof coaxial with the said bellows and extending substantially the length of the said sheath. Such reinforcement, besides strengthening the rubber or like sheath, would, in the case of fire, baffle the flame before burning through and thus reduce the risk of failure of the coupling due to fire.

80 Although as stated above the reinforcement is conveniently formed of wire gauze, it could, of course, be formed of metal mesh or fire-resistant fabric braid or mesh, if desired.

85 The said rubber or like sheath may itself be enclosed in a covering of a reinforcing or protective material which may, for example, comprise tubular metal braiding.

90 According to a further feature of the invention the said flanges comprise annular discs having tubular coaxial bosses, into which are introduced the cylindrical ends of the bellows, these cylindrical ends being secured to said

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between the said end flanges and the end corrugations of the bellows to fill these recesses and the troughs of the said last corrugations of the bellows, and is bonded in any suitable manner to the inside surfaces of the end flanges, a strip of wire gauze being embedded in the said sheath as the latter is moulded over the bellows, said strip being wound in the sheath so as to form a tube internally of the sheath coaxial with the said bellows and extending substantially fully between the said end flanges. The said rubber or like material forms a sheath extending entirely around the bellows to a suitable thickness, which is, less than the radial extent to which the said flanges project from the bellows so that an annular marginal portion on each of these flanges is left which can be spun inwardly and downwardly into approximately frusto-conical form gripping and protecting the ends of the said rubber or like sheath.

If desired, a braided metal or other covering or coverings may be provided around the said rubber or like sheath before the marginal portions of the said flanges are spun inwardly.

By constructing the coupling element in the manner above described, additional security is achieved whilst not reducing to any appreciable extent the flexibility of the coupling. The rubber composition reinforces the corrugated metal tubing or bellows and in addition damps out vibrations which might be induced therein in use and which might result in fracture of the bellows.

Although, according to this invention, the said bellows may as hereinbefore stated be provided with annular or helical corrugations, when the bellows have annular corrugations, the additional advantage is obtained in that the rubber or like sheath serves to seal, at least temporary, and to localise any fracture that might develop in the metal bellows at any point therein.

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